CANADA

National Energy Board

In the Matter of a Public Inquiry into an Accident at the Liebenthal Purchase Meter Station on the Pipeline System Owned and Operated by TransCanada PipeLines Limited

February 1984

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National Energy Board
Order No. MH-2-83

IN THE MATTER OF the National Energy Board Act and the Regulations made thereunder;

AND IN THE MATTER OF an accident at the Liebenthal Purchase Meter Station on the pipeline system owned and operated by TransCanada PipeLines Limited. Board File No.: 1595-T1-5.

HEARD AT Leader, Saskatchewan on: 6 and 7 December 1983

BEFORE:

J. Farmer	Presiding Member
J.R. Jenkins	Member
A.B. Gilmour	Member

APPEARANCES:

R.B. Cohen	TransCanada PipeLines Limited
N.J. Schultz	National Energy Board

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Abbreviations and Definitions

COOP	Codes of Operating Procedures
KMP	Kilometer Post
NEB or the Board	National Energy Board
PMS	Purchase Meter Station
psi	Pounds Per Square Inch
Run	Meter Run
Sask. Power	Saskatchewan Power Corporation
SMS	Sales Meter Station
TCPL	TransCanada PipeLines Limited
TP-9	TP-9 Turbine Meter
TransCanada or the Company	TransCanada PipeLines Limited

National Energy Board
Canada

Pipeline Accident Report
Order No. MH-2-83

TransCanada PipeLines Limited
Industrial Fatality
Liebenthal Purchase Meter Station
28 September 1983

Synopsis

At approximately 0945 h, MDT, on 28 September 1983, the measuring module of the TP-9 meter of meter run #1 at the Liebenthal Purchase Meter Station was ejected from the body of the meter under full line pressure during the performance of routine station servicing. One TransCanada employee was killed and a second employee sustained injuries. The Rockwell TP-9 turbine meter and the meter station building were damaged during the accident.

Following an investigation and public inquiry into this matter, the National Energy Board determined that the probable cause of the accident was the failure of the employee to follow proper Company operating procedures. Specifically, the failure of the employee to isolate and blow down the meter run prior to dismantling the meter. A contributing factor was that, unlike other methods of securing closures on high pressure gas piping which give a warning of the piping being pressurized by leaking first before a sudden release of pressure, there was no such warning that the meter body was under pressure with the type of retaining clamp utilized on the TP-9 meter.

Events Preceding the Accident

On the morning of 28 September 1983, two TransCanada employees, Messrs. Betts and Bosch, were dispatched from the Sub-District 1002 offices at Burstall, Saskatchewan to the Liebenthal Purchase Meter Station. Their instructions were to replace a gas sample bottle, calibrate the Mercury Full Scallop Recorders and perform a spin test on the TP-9 turbine meters of the two station meter runs. This was a normal task assignment.

The Accident

The two men arrived at the station at 0900 hours. They gained access to the meter station through the perimeter fence gate and the meter building door.

Upon entering the meter building the men assessed the status of the station by observing the positions of the various valves and the gauge and meter readings. They determined that meter run #1 was in service and meter run #2 was shut down.

Mr. Betts observed that the #1 meter had a pressure of over 800 psi and the #2 meter was down to zero. Both meters are fitted with temperature/pressure recorders and pressure gauges. Mr. Betts suggested that Mr. Bosch obtain a gas sample from meter run #1, while he (Mr. Betts) would proceed with the calibration of the #2 meter. It was planned that Mr. Betts would finish off work on run #2, place it back in service, and then Mr. Bosch would proceed with the calibration of run #1.

Mr. Betts proceeded to remove the temperature/pressure recorder from the #2 meter and extract the TP-9 meter module. He performed a spin test on the module and found the spin time slower than required. Mr. Betts then changed the bearings in the meter module and performed a second spin test. The second test proved satisfactory and he reinstalled the meter module in the meter body, securing it with the retaining clamp. At this point, Mr. Bosch assisted Mr. Betts in reinstalling the temperature/pressure recorder on meter run #2.

While Mr. Betts was performing these tasks, Mr. Bosch obtained the gas sample from the #1 meter run. Mr. Betts and Mr. Bosch then removed the temperature/pressure recorder from run #1. Mr. Betts turned back to meter run #2 and removed the counter device between the TP-9 and the recording meter. He then turned to observe Mr. Bosch. Mr. Bosch had removed one of the half clamps on the #1 meter and was proceeding to knock the second half clamp off. At this point, there was a sudden release of high pressure gas.

The force of the gas escaping from the line caused the measuring module of the TP-9 to be expelled from the meter body and lifted Mr. Bosch through the north side roof of the meter building. His body was found on the ground 5.5 m from the south wall of the building.

Mr. Betts, on recovering from the pressure wave inside the building, first tried to open a door to get out but could not get the door open. Mr. Betts then realized high pressure gas was still escaping inside the building and proceeded to close the upstream valve on meter run #1. This action, in conjunction with a downstream check valve, stopped the flow of gas. Mr. Betts managed to open the door of the building and found Mr. Bosch on the ground outside. Using the radio in his vehicle, Mr. Betts reached his supervisor in Burstall at 0949h, MDT, and requested assistance. TCPL notified the Leader, Saskatchewan detachment of the Royal Canadian Mounted Police. The Corporal who headed the detachment was the first person on the scene, followed shortly by TransCanada personnel.

Injuries to Persons

Two TCPL employees were injured as a result of the incident.

Mr. Henry Peter Bosch, a Level V Utilityman, was fatally injured. Mr. Bosch was 38 years of age and had been employed by the Company for 15 1/2 years.

Mr. Wilson J. Betts survived the incident, sustaining two broken fingers, a partial loss of hearing and shock. Mr. Betts, a Level I Utilityman, was 50 years old and had been employed for 20 months with TCPL.

Damage to the Purchase Meter Station

The accident resulted in damage to the meter station building and to the meter itself.

The measuring module of run #1 was expelled through the roof of the building directly above the installation. The building walls were buckled inward, all windows were broken and the glass imploded into the building. Components of the measuring module were separated and scattered outside of the building. One half of the retaining clamp and the clamp nuts and bolts were found inside the building.

There was no interruption to pipeline service; however, the supply of gas from Sask. Power was interrupted for just over 2 days, at which time the meter station bypass was placed in service.

Design of the Liebenthal Purchase Meter Station

The Liebenthal purchase meter station is located at Mainline Valve 3 + 9.88 km or KMP 45.02 on the TransCanada PipeLine system. The purpose of the station is to measure volumes of natural gas from Saskatchewan Power Corporation tendered for shipment on the TCPL 864 mm diameter mainlines #100-1 and #100-2.

The meter station facilities comprise two meter runs of 89 mm diameter pipe with two Rockwell TP-9 Turbine Meters. The meter station was designed to provide for gas metering on either of runs #1 or #2 individually, the dormant meter serving as a standby to avoid service interruptions during routine maintenance and calibration.

Each meter run is equipped with isolation plug-type valves on the upstream and downstream side together with check valves to arrest any flow of gas from the TCPL mainline to the Sask. Power delivery lines. Both meter runs were also equipped with venting lines and valves used to vent the line pressure to atmosphere and pressure gauges for measuring the internal pressure of the meter runs. Mounted on each TP-9 meter device was a model 1238 Mercury Full Scallop Recorder. Meter run #1 contained an Arco Continuous Sampler.

The station building is a prefabricated steel structure approximately 2.4 m x 3.7 m and is both insulated and heated. Two hollow metal doors provide access to the meter station from the west and east ends. The station yard is surrounded by a 1.8 m chain link fence with a locked gate.

Figure 1 presents a schematic diagram of meter run #1 at the Liebenthal PMS facilities.

TP-9 Turbine Meter

The TP-9 meter is an axial flow type meter (flow of gas is parallel to rotor axis) that contains a vaned rotor at the inlet port on the device. The flow of gas impinges on the rotor which rotates at a speed proportional to the rate of flow. A measuring module translates the rotation of the rotor shaft into measurement of gas volumes by means of a reduction gear assembly and in turn provides volume-related movements to the Mercury recorder mounted on top of the measuring module.

The entire flow interpretation and measuring mechanism of the TP-9 meter is contained within the meter housing. A pressure seal is made by a half clamp device compressing an 'O' ring between the flanges of the upper plate and the meter housing. The half clamps are drawn together around the mating flanges of the measuring module upper plate and the meter housing by two cap screws and nuts. The external flange surfaces are tapered and the tapered internal mating surface of the half clamp provides a compressive force to the flanges when the bolts are tightened.

In order to inspect and service the TP-9, the measuring module must be removed. By releasing the half clamps, the upper plate of the measuring module can be removed. All of the measuring module components are fixed to this plate and are extracted from the meter in this fashion.

At the Liebenthal PMS, the TP-9 meters were mounted with the axis of the rotor shaft vertical and inlet port down.

The half clamps on the meter each had a warning sign fixed to them by the manufacturer. The wording of the sign was as follows:

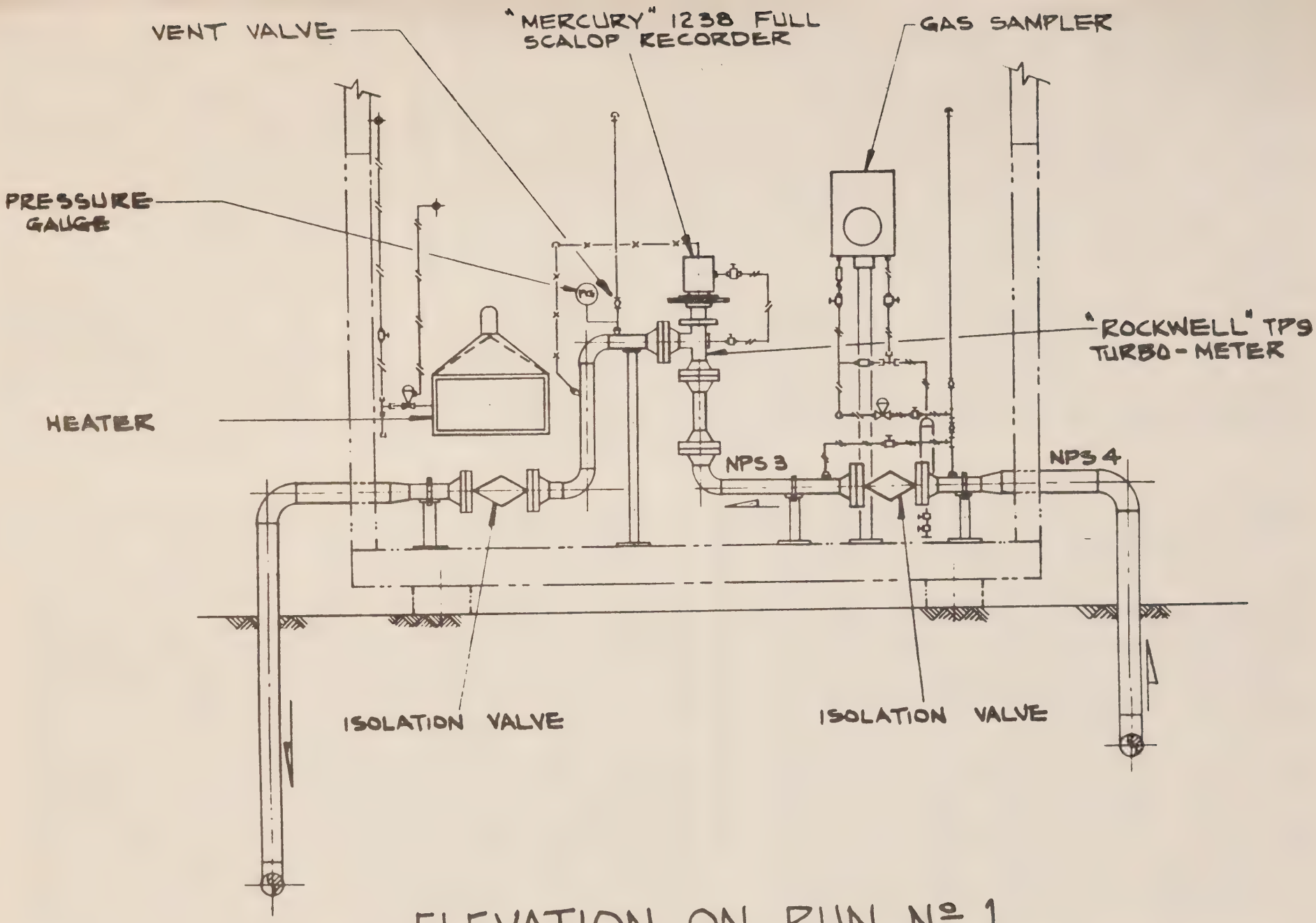
"Caution. Relieve pressure in meter before removing clamp".

Company Training Program

TransCanada's operating and maintenance staff are grouped in four classifications. The entry level is the Maintenance category. There are seven levels in the Maintenance category, Level I being the lowest. The Utility classification is next and consists of five levels. The next classification is the Welder. In this category, there are three levels. The final classification is Technician, which is divided into six levels.

All new employees start in the Maintenance category. Depending on previous experience and qualifications, an employee may be hired at any level within the classification. Normal progression from a Level I to a Level VII takes 5 years. During this period, the employee receives on-the-job training from qualified employees in a variety of operating and maintenance tasks.

Before qualifying for promotion to the Utility level, the employee must meet a set of standards known as the Qualification Standards. These requirements are detailed in the Training and Appraisal Standards. The training program includes on-the-job demonstrations, supervised hands-on experience, program learning modules, video tapes and formal training schools. The written procedures for most jobs are detailed in TCPL's "COOP", or codes of operating procedure,



ELEVATION ON RUN Nº 1

Exhibit No. 15
NEB Order No. MH-2-83

FIGURE 1

which are kept in the sub-district offices. The employee's training progress is documented and his performance reviewed with him at least once a year. Training and appraisal standards are also used to qualify employees for promotion to the Technician and Welding classifications.

Both Messrs. Bosch and Betts were classified as Utilitymen, Mr. Bosch a Level V and Mr. Betts a Level I. Mr. Bosch functioned primarily as an operator at one of TCPL's compressor stations. As part of TransCanada's program to keep employees familiar with gas measurement, he would work on maintenance for four days every five weeks. Mr. Betts worked mainly on gas measurement equipment maintenance. Although Mr. Bosch was classed at a more senior Utility level, when the two men worked together on gas measurement functions, Mr. Betts acted as the "lead hand", or the person in charge.

Both Messrs. Bosch and Betts had received on-the-job training in the procedures for gas measurement equipment calibration. Both men had previous experience in spin testing the TP-9 meters at the Liebenthal station. Mr. Bosch was known to have read the COOP covering turbine meter spin tests and Mr. Betts was known to have used the COOP manual to complete meter station calibration reports. Mr. Betts had completed the training module covering the basics of gas measurement. Mr. Bosch had completed this same training module as well as one covering measurement equipment. Mr. Bosch had viewed the video tape covering the dismantling and spin testing of a TP-9 meter. Neither Mr. Bosch nor Mr. Betts had attended the Company Standard Gas Measurement Phase I course. This course included a description of procedures for isolating and depressurizing piping for the safe removal of measuring equipment and a description of procedures and demonstrations for conducting turbine meter spin tests.

Operational and Safety Procedures

In order to maintain the accuracy and serviceability of a turbine meter it is required that each unit be inspected on a regular basis. The Liebenthal station was inspected once every 30 days.

To perform a turbine meter inspection, part of the procedure requires that the turbine rotor be manually accelerated then timed to a full stop to determine that the frictional drag (resistance to rotation) within the meter has remained acceptable. Accordingly, at each scheduled inspection, the turbine meter measuring module must be removed from the meter body by releasing the half clamps and extracting the module.

TransCanada utilizes a number of documents which describe the Company's approved procedures for performing inspection and maintenance operations. The meter station manual, a copy of which was placed at the Liebenthal PMS, contained the operating instructions PMD-OI-02-01 "Turbine Meter Stations Inspections - Types and Intervals" and PMD-OI-02-02 "Turbine Meters - Spin Tests". The former describes the type and frequency of inspections to be carried out at a turbine meter station and refers the reader to appropriate detailed procedures contained in the Company's COOP documents. The latter outlines test frequency procedures, spin test times and reporting requirements specific to turbine meter spin tests.

Both of the above procedures contain a specific reference to the requirement that a turbine meter be relieved of internal pressure prior to dismantling. Neither of the documents contain a description of the steps to be followed to relieve internal meter pressure.

TransCanada's Safety Manual presents the Company's rules and standards which have been formulated to provide protection and awareness for its employees. The text of the Safety Manual does not contain a specific reference to spin testing TP-9 meters; however, specific reference to the requirements and procedures for venting high pressure gas appliances prior to maintenance is made. The Company augments its Safety Manual with regularly scheduled meetings to reinforce employee training in Company Safety Policy and Procedures.

Previous Incidents Involving TP-9 Meters

TransCanada has had four previous incidents involving the release of the TP-9 turbometer closure half clamps while under internal pressure. All of these incidents resulted in the ejection of the meter module and injuries to the persons performing the work.

The first incident occurred on 4 October 1976 at the Broadview Sales Meter Station in Saskatchewan during a routine operational check of the facility. It was not determined whether the employees had closed the upstream and downstream isolation valves or whether they had isolated the meter run but had not blown down the run prior to removing the module retaining clamps. A TCPL employee sustained a temporary loss of hearing and received facial abrasions as a result of the accident. Following the incident, TransCanada recommended the installation of pressure gauges on all TP-9 meter runs.

On 16 May 1977, at the New Liskeard SMS in Ontario, a TP-9 module was ejected from the meter body and became lodged in the roof of the meter station building. The employee had been performing a regular six-month spin test and had not completely blown down the run before removing the clamps on the turbine meter. The meter run was not equipped with either a blowdown line or pressure gauge. A 6.4 mm sensing line was used to vent the meter and listening for the exhaust of gas was the only means used to determine that the run was blown down. After the accident, the vent line was found to be closed. It was not determined whether the blowdown valve was closed prior to the employee proceeding with the

work or whether he had closed the valve after the incident to secure the station. The employee involved suffered cuts, abrasions and a temporary loss of hearing. Following this incident, pressure gauges were installed on all meter runs. TransCanada also determined that more instruction on a safer approach to blowdown was required.

The third incident occurred on 28 February 1980 at the #4 unit of Station 105 at Ramore, Ontario. A spin test was being performed on a TP-9 meter that was installed on the fuel gas piping to a compressor unit. The piping and meter had been blown down using the unit surge tank vent lines. There were no specific vent lines installed at that station for the purpose of blowing down the meter run. The gauge on the surge tank read zero psi; however, the fuel meter gauge indicated that one pound of pressure existed. The employee closed the surge tank vent line valve and then proceeded to remove the module. The measuring module ejected from the meter body, striking the TCPL employee on his eyebrow. As a result of the accident, TransCanada installed a vent line on the fuel run and a second vent line on the pressure gauge line. The second vent line was installed at this station only and its purpose was to give employees a physical means of checking the meter body pressure. TCPL also recommended that employees be instructed to have positive indication that no gas is remaining in enclosures when working on them.

On 30 April 1981, a TP-9 module was ejected from the body of the meter on the unit at Compressor Station 2, Burstall, Saskatchewan during the performance of a spin test. The turbine meter was installed on the fuel gas piping for a gas turbine at the station. The meter run had been isolated and blown down and the run pressure gauge had read zero. The blowdown valve was closed and then re-opened before the meter was dismantled. Upon removal of the retaining clamps, the measuring module ejected because of a pressure buildup in the meter caused by a leaking isolation valve. The TCPL employee received a cut on his thumb as a result of the accident. The employee had never previously performed a spin test, although he had observed the procedure. TransCanada determined that more experience and awareness on the part of the employee might have prevented the incident. The Company attributed the cause of accident to the isolation valve leakage and an erroneously reading pressure gauge, which they felt could have been corrected by more detailed maintenance.

Other Information

Metallurgical Analysis - A metallurgical report was prepared by Hanson Materials Engineering (Western) Ltd. The Consultants were sent the components of the turbine meter and requested to check the assembly to determine whether or not it could become separated without first being dismantled. They were also requested to examine the components of the meter for any material defects.

Hanson's findings concluded that the meter assembly could not come apart until at least one of the clamping bolts was completely disengaged and the second loosened. There were no material or manufacturing defects found which could have contributed to the accident.

Canada Department of Labour Report - An accident investigation report was prepared by the Accident Prevention and Compensation Branch of the Canada Department of Labour. The report attributes the causes of the accident to the following: deviating from job procedure (working on lines 1 and 2 simultaneously); failure to shut off gas; failure to bleed off gas; and, removing the meter and recording assembly under pressure.

Post Mortem Report - An autopsy was conducted on the body of Mr. Bosch by the Union Hospital in Swift Current, Saskatchewan. The pathologist determined the cause of death to be cerebral lacerations due to fracture of the skull base. No alcohol was found in the blood.

Analysis

The Accident

Both Messrs. Bosch and Betts were aware, having assessed the status of the station upon their arrival, that meter run #1 was loaded and in service.

The procedure of exchanging a gas sample bottle requires that the new bottle be purged several times before it is placed in service. Mr. Bosch was therefore aware that run #1 was loaded throughout the time he worked on replacing the gas sample bottle on this run.

Both men had received Company training in the procedures for gas measurement equipment calibration and both had previous experience in performing this task.

Mr. Bosch, with his training, experience and awareness of the operational mode of run #1, should have known that it was necessary to isolate and blow down the meter run before removing the meter retaining clamps.

Design

The design of the Liebenthal Purchase Meter Station is typical for facilities of this kind. The National Energy Board approved its operation by Order No. GPMO-T1-1-76.

The Board noted that at the time of the accident, the Company had not complied with subsection 74(1) of the Gas Pipeline Regulations that requires that all manifold piping be marked and identified by the use of signs, stencils or color coding.

The Board also noted that at the time of the accident, one of the manufacturer's warning signs that were fixed to each of the TP-9 module retaining clamps had been painted over, completely obliterating the warning. The Board understood that subsequent to the incident, TransCanada restored or replaced any such defaced signs on their equipment.

While the half clamp retaining flange on the TP-9 measuring module facilitates ease of maintenance in that it provides a simple and quick procedure to remove the closure device, it does not offer a positive means to prevent human error. Subsequent to the accident, TransCanada PipeLines devised a clamp cover guard that will provide the employee with a warning that the line is loaded before he can remove the half clamps. The clamp cover guard fits over the half clamps making removal of the clamps impossible while the guard is in place. To lower the cover guard, the employee must undo a Plico plug with a wrench. At this time, if the line were still under pressure, the employee would hear the noise of gas escaping through a hole in the Plico valve. When the plug is fully removed, the guard lowers enough to expose the half clamps for removal. The clamp cover guard is permanently fixed to the meter. Figure 2 illustrates the side view of this safety cover installation.

The Board is aware that the half clamp type of closure is used on other types of valves, such as blow-off valves, and would expect the Company to recognize these other uses as potentially hazardous.

Training Program

The Board has reviewed the Qualification, Training and Appraisal Standards that a TCPL employee is required to meet in order to qualify for promotion to the Utility classification. The training program appears to be sufficient, requiring the employee to have a theoretical as well as practical knowledge of the tasks that he will be required to perform. The emphasis of the program is on supervised on-the-job training, which is a reasonable means of providing the employee with the knowledge and skills necessary to work both effectively and safely. The Board believes that mandatory refresher courses which highlight the key safety and procedural aspects of TransCanada's training program would assist employees in maintaining a high level of operational awareness.

The Board noted that TransCanada's Qualification Standards were updated as of June 1983. A new requirement, for employees to successfully complete the Company Standard Gas Measurement Phase I course, was added at that time. This course would appear to be very useful to TCPL employees and the Board encourages its implementation.

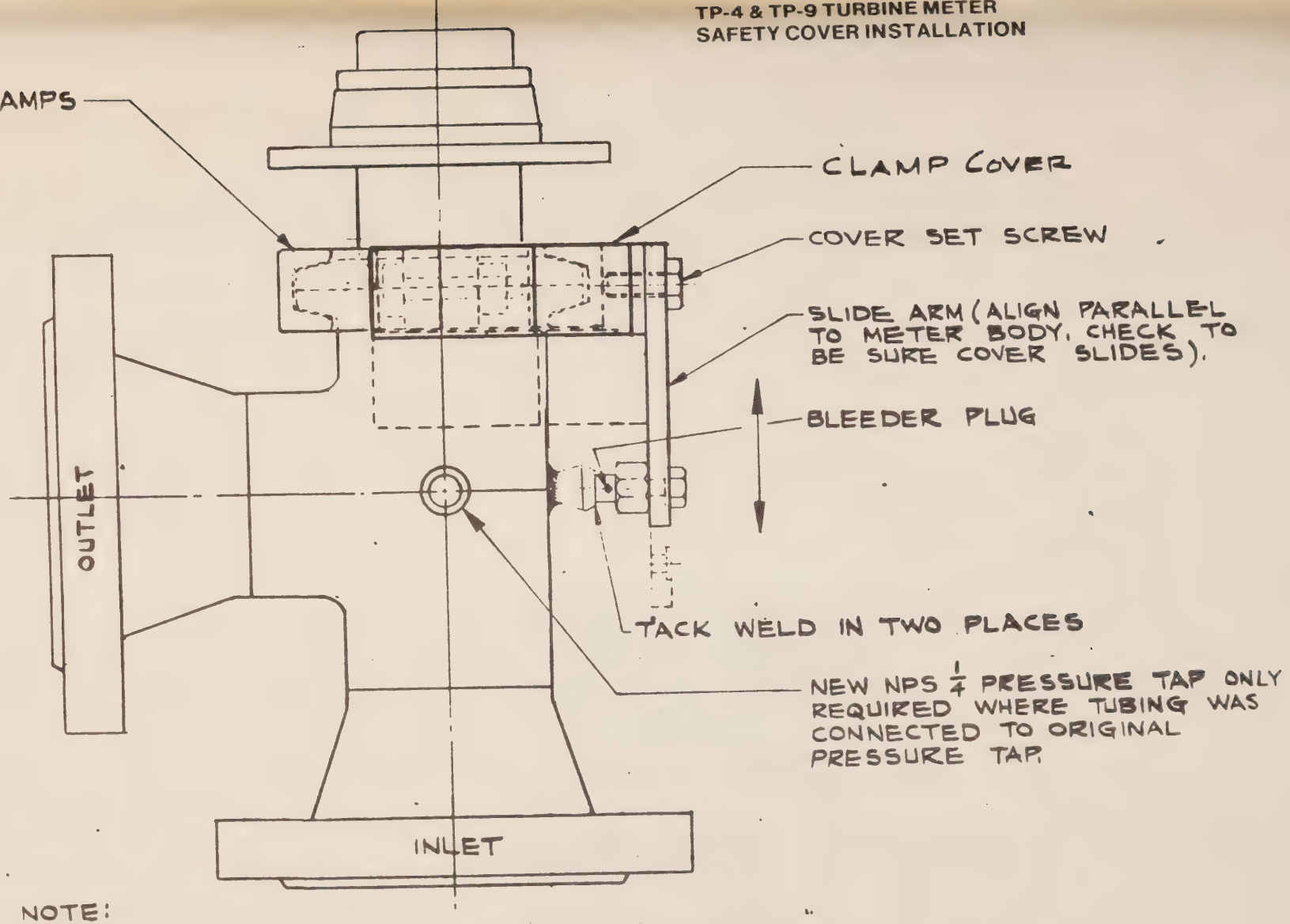
Operational and Safety Procedures

The Board's review of the Company's Codes of Operating Procedures (COOP) indicated that these documents were comprehensive with respect to the performance of a turbine meter spin test. The procedures to be followed for such a task were set out in a sequential and logical format and included an advisory statement indicating that the internal pressure within the meter must be relieved prior to dismantling. Further, the advisory statement is well positioned at the beginning of the step-by-step procedure.

The Board noted, however, that within the spin test procedures no sequential steps describing blowdown or venting operations are included. Further, these procedures do not contain a reference to the meter run pressure gauges which were installed to indicate to field personnel the status of internal pressure in a meter run. The Board is of the opinion that the inclusion of specific steps in the COOP documents to describe venting procedures and the inclusion of a procedure to verify complete venting are required.

The Board noted that the Safety Manual does not contain a specific reference to the requirements of venting gas measurement appliances prior to servicing. TransCanada stated that this aspect was covered in their on-the-job training program. The Board believes that the Safety Manual is intended to provide an awareness to employees of potentially dangerous situations. Therefore, in the Board's opinion, the Safety Manual requires an installment that outlines in specific terms the safety-related aspects of performing routine tasks on high pressure gas equipment. Included therein should be specific references to blowdown requirements and methods of verification, together with references to the applicable COOP documents.

TP-4 & TP-9 TURBINE METER
SAFETY COVER INSTALLATION



NOTE:
NORMAL POSITION SHOWN IN HEAVY OUTLINE.
OPEN POSITION SHOWN IN DOTTED LINES.

SIDE VIEW

Exhibit No. 16
NEB Order No. MH-2-83

FIGURE 2

Conclusions

Probable Cause

The National Energy Board determines that the probable cause of the accident was the failure of the employee to follow proper
Company operating procedures. Specifically, the failure of the employee to isolate and blow down the meter run prior to dismantling the meter. A contributing factor was that, unlike other methods of securing closures on high pressure gas piping which give a warning of the piping being pressurized by leaking first before a sudden release of pressure, there was no such warning that the meter body was under pressure with the type of retaining clamp utilized on the TP-9 meter.

Disposition

On the basis of the testimony and submissions introduced during the public hearing and as a result of its investigation into the matter, the National Energy Board directs that:

1. TransCanada PipeLines Limited implement the following recommendations found in the Company's Industrial Fatality Report which was filed as part of Exhibit No. 5 to the public inquiry:

   8.3 All valves within all meter buildings should be equipped with valve identification signs as per the valve I.D. listing in the Corporate Identification Standards Manual.

   8.4 Although the TP-9 turbine module retaining clamp accommodates ease of maintenance, it does not offer means to account for human error. A modification to provide for a physical interlock system should be pursued by Engineering, the Field Transmission group and the Vendor of the TP-9 and fitted immediately.

   8.11 A section on safety precautions associated with handling of high pressure gas should be added to the Safety Manual.

   8.12 A survey should be conducted to determine if there are other applications of similar closure devices for containment of high pressure in use by TransCanada PipeLines. This will identify the need for recognition of such hazards and earmark them for possible redesign.

2. TransCanada PipeLines Limited implement periodic mandatory refresher courses for all field employees. These refresher courses should highlight the key safety and procedural aspects of TransCanada's training program.

3. TransCanada prepare a detailed description of procedures for venting internal pressure prior to dismantling high pressure gas measurement equipment. This procedure should appear in the Company's COOP, spin test procedures and all other documents relating to the inspection and maintenance of high pressure gas equipment.

4. TransCanada PipeLines Limited provide the National Energy Board with a written progress report every six months indicating the status of each of the above directions, until such time as each has been fully implemented.

J. Farmer
Presiding Member

J.R. Jenkins
Member

A.B. Gilmour
Member

Ottawa, Canada
February 1984

Investigation and Hearing

Investigation

The National Energy Board was notified of the accident at 1630h, EDT, on 28 September 1983. The NEB immediately dispatched a pipeline inspector to the accident site to conduct an investigation.

Other parties who conducted investigations into the incident were the Royal Canadian Mounted Police on behalf of the local Coroner, the Canada Department of Labour, and TransCanada PipeLines Limited. The Workmen's Compensation Board was notified of the accident.

Public Hearing

The National Energy Board ordered that a public inquiry be held to investigate the accident. The two-day hearing was held in Leader, Saskatchewan, beginning 6 December 1983.

During the course of the hearing, TransCanada was granted the opportunity to make a written submission to the Board by 6 January 1984. In their filing dated 6 January 1984, TCPL stated that they were content to rely on the oral and written evidence introduced during the hearing.